SCIENCE AND TECHNOLOGY: OLD ASSUMPTIONS AND NEW CHALLENGES

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Presentation given to the seminar on "higher education, science and technology in Latin America" organized by the Latin American Scholarship Program, Harvard University, November 8, 1996.

Simon Schwartzman: Thank you very much. When Lew Tyler asked me to participate in this event, talking about science and technology, I said that I did not have anything new to say on the subject since the conclusion of the science and technology policy study I coordinated a couple of years ago in Brazil. Instead of withdrawing the invitation, he was kind enough to agree that I could talk about the main conclusions of that study, and this is what I intend to do today.

This study was my second attempt to participate in a policy study of this sort, to try to make to make an evaluation of a whole area of activities and suggest a new policy orientation. The first one was in 1985 when I was part of the national commission created by the Brazilian government to evaluate the higher education sector. Our main suggestions at the time, if I can summarize in two words, were that higher education should diversify, and should be evaluated systematically. At the time the conclusions of the Commission drew strong opposition, and were set aside by the government. Now, ten years later, the Ministry of Education created the first system of national evaluation of undergraduate course programs - and is doing it under a storm of protests and resistance. So these things take a long time. It is naive to suppose that policy recommendations would be implemented just because of their quality, as if the government would read them and say, "well, that's the light, and we'll follow the light." The important point about the 1985 Commission was that it identified the main issues related to Brazil's higher education system, and helped to set the agenda for discussion and eventual policy initiatives in subsequent years.

The first task when one engages in this kind of study is to identify what are the standard assumptions, the standard understandings, of what the reality is, and try to challenge that. When we talk about universities in Latin America, one of the first assumptions that have to be challenged is that they are all future Harvard's, or should evolve to become like Harvard. This idea, that there is just one organizational and institutional model for higher education, the model of the best US or European research universities, and that everything else is just an approximation or a degradation of the ideal model, is widespread in Latin America, and has had very negative effects. We said this very explicitly in the 1985 policy paper on higher education, stressing that most of the higher education institutions in Brazil are just teaching institutions, cannot aspire to be like Harvard or Cambridge, and that it would be important to recognize the importance of teaching without the pretenses of research. Thee years later, the new Brazilian Constitution, written after the reestablishment of civilian rule, insisted that, in higher education, teaching, research and extension work

are "inseparable," and, by implication, that good education as such was an unworthy goal for the country's higher education establishments.

If you discuss science and not only higher education, you have a similar task. What are the standard assumptions one has to confront, and to try to show that they eventually can be different? One of the standard assumptions is the so-called "endless frontier" model of science, the assumption being that scientists should be free to pursue any kind of undertaking they feel like, and if you support all kinds of curiosity and the interests of individual scientists with enough money, based only on the quality of their work, everything else will follow: you will have applied technology, economic development, good training and good education.

This assumption is very central in the way academic science takes place in many countries. It was very important here in the U.S., it was important in Brazil, as well as in most of Latin America. But is just a kind of ideology. It is a justification and disguise for what really takes place. When you look in more detail at what happens with scientific activity, you see that the free, unintended, spontaneous kind of science, in which scientists do whatever they want and get support for their good ideas, is just part of a much broader undertaking. This is not something new. Science has been always like that.

Jean-Jacques Salomon, a well-known student of science policy questions in Europe, has been saying this for a long time. Salomon was very involved in the OECD efforts to introduce science planning and somehow to direct science activities in Europe. I want to quote here, just to stress his view, one small limerick he included in a book with the proceedings of an assessment of the science and technology system in Israel. Salomon was talking about the links between scientists and industry, military research, applied research and all kinds of practical activities which are very much part of their activity. He said that

> There was this young lady of Kent
> Who said that she knew what it meant
> When men asked her to dine,
> Gave her cocktails and wine –
> She knew what it meant, but she went.
>
> [Laughter.]

Scientists, of course, knew all the time that their work is not that "free," "unintended" and "unencumbered" from any kind of relationships, but is always part of a much broader activity. Professor Lewis Branscomb has shown in one of his writings that, after the Second World War, the United States was able to develop, simultaneously, a huge military research establishment and an important system of academic research which worked under very different principles and assumptions, but in reality were strongly linked. The big technological projects of the cold war were very important sources of support for the academic, long-term and "disinterested" research

done in universities and other research centers, and it is not a coincidence that, now that the cold war is over, academic science is also suffering.

These two components are very important in those countries that are ahead in scientific and technological research. One is the so-called "basic science," which is much smaller, in money and people involved, than the other side, which deals with industrial technology, the use of innovation and knowledge for industrial development and growth. If you look at the international scene today, what's changing is not just that science is becoming linked with applied work, with technology, with other things - this is nothing so new. What is being changed is the whole idea, the whole *ideology* of pure science - that science is always good for you, you have to give the money for the scientists and don't ask what they will do, they will always do good things - all this is being challenged. People now are much more skeptical, much more doubtful about this. Research is getting ever more expensive; it is also getting ever more linked with short-term economic interests, more linked and intertwined with industry. The military establishment, used to support long-term and very ambitious projects with unlimited government support, is not here anymore, or at least is being reduced. In short, the illusions about pure science are disappearing.

Academic science is feeling the strains of the new situation everywhere. But this is less of a novelty in the US, where the links and bridges between basic and applied science have always existed, than in many Latin American countries, where, in the absence of a significant technological sector, the ideology of pure science was and still is very strong. Scientists sometimes interpret the challenge to the pure science model as a threat to their independence and autonomy, and they have reasons to worry.

The second step, after describing the way scientific activity was justified, is to look at what is actually happening. For Brazil, we showed how the country developed in the 70s, during the years of the military government, a kind of scaled-down version of the same process you had in the US. On one hand, very ambitious military projects - the nuclear program, space rockets, satellites, nuclear submarine, military and civilian aircraft. On the other, this idea that one should do science in universities and develop American-style graduate programs, research programs, fellowships, and so forth. This alliance between the military and the academics was a notable feature of those years, particularly because of the opposite political ideologies usually held by leading figures of the two sectors. Nowhere was this alliance as strong as in the failed attempt to develop an indigenous computer industry in Brazil, in the very same years that the microcomputer revolution was starting to sweep the world.

This was a very short-lived alliance. It started in the late sixties, and was already crumbling in the early eighties, when the Brazilian military regime started to wear out. They abandoned their big project to make Brazil a world power in a few years in the early 1980s, and handed power back to the civilians five years later. But this short-lived alliance was enough to create a sizeable

constituency of researchers and research institutions claiming for public support. In the early eighties Brazil had about one thousand graduate programs in all fields of knowledge, about fifty thousand people somehow living out different types of research money - fellowships, grants, public salaries - and several thousand more in institutions created to provide support for these people and their institutions.

In short, Brazil developed the largest system for science and technology research in Latin America, strongly based on universities, with a linkage with very ambitious technology projects, which entered into a crisis situation very quickly. Power became much less concentrated, and resources much more scarce with the civilian regime after 1985. In an open, democratic system, everything had to be negotiated, and the science sector became just one among other sectors fighting for public resources. In this new climate, the old argument that science had to be supported on itself, in theory to advance knowledge and help the development of the country, in practice to maintain the scientists and their institutions became very difficult to maintain. The question now is how to turn science and technology more relevant, not in abstract terms, but in ways that are visible and convincing for those who have to decide about the distribution of public resources.

One of the characteristics of the scientific programs that were established and developed so quickly in the seventies was that their quality was very uneven, and concentrated in a few institutions whose scientific and technical traditions dated from many years before, like the Universidade de São Paulo, the Universidade do Rio de Janeiro and a selected number of research institutes. One of the reasons why quality was so low was that Brazil attempted to do in science was it had tried to do in industry, the so-called import substitution policy. The idea was that, to develop national industry, it was necessary to protect it from the competition of foreign firms and the introduction of foreign technology. National industry was not expected to be very efficient at the beginning, but the assumption was that it would mature and come to a point where they could compete internationally in an equal basis.

For a while, this strategy seemed to work, but now we're paying the price. In the '80s the economy stopped, industrial products became too expensive, and the country lost competitiveness. The policy for science was similar in many respects. The assumption was that, even if a research group were not very good, if you provided it with support, it would eventually improve. This was also the rationale to support research groups outside the main academic centers in São Paulo and Rio de Janeiro, since, if the science supporting agencies evaluated project according strict criteria of quality, resources would flow only to the best-endowed institutions and groups. The consequence of this policy was the resources for research were spread thin, and the number of people claiming for subsidies in the name of science kept growing.

A further development took place around 1986 or 1987, when inflation was at its peak, and it was impossible to predict whether resources allocated for science and technology in the Federal budget - or, for that matter, for almost anything else - would materialize and keep their real value preserved. The main exception was that public employees would get their salaries every month, indexed each time for currency devaluation. The solution found by the administrators at the Ministry of Science and Technology and the National Research Council was to turn most of their money into fellowships, and get assurances from the executive that fellowship money should be treated as salaries. This may have been an ingenious stratagem for survival in a difficult moment, but, now that the currency is stable and budgets are more predictable, about 70% of the resources allocated for the National Research Council go to fellowships. Today in Brazil there are about 50 thousand persons a year enjoying research and graduate education fellowships, most of them in master's programs, which are known to graduate only a small percentage of their students. The fellowship programs from the National Research Council and the Ministry of Education became, in essence, a mechanism for subsidizing a small group of students, most of whom are unlikely to become researchers, and have already benefitted from the advantages of free education in public universities.

In short, the attempt to preserve the resources for research in a period of intense inflation led to a situation in which most of the research money is used to provide subsidies to students who use them to postpone for a few years the entrance in the labor market, while they improve their skills and accumulate credentials to get the best positions later. This is not the full picture, of course, since many of these students are being trained in scientific careers they would pursue if it were not for the fellowships, and there are also fellowships for researchers and for worthy graduate studies abroad. But this is just a small part of the whole, which is used to justify the rest.

The third question is "Well, how can you change that? How can one make the money given to research and graduate education more relevant, more meaningful to society?'

One view is to insist that the current arrangements are as good as they can be, and ask for more money to make it better. "Given the country's size," the argument goes, "the number of fellowships is still small, and some wastefulness is unavoidable. Besides the fellowships, we need more money for academic research, and subsidies to develop innovation capabilities in industry." Whatever we have, even if not very good, should be preserved, and wait for better times." My feeling is that this is still the prevailing attitude in Brazil, where the notion that we live in a world of scarce resources requiring decisions about priorities is very difficult to take hold. It is a way of avoiding decisions that may be painful, but it is also a way of maintaining an inefficient research system, which would be probably unable to make good use of more money if were to receive it.

The opposite, and also extreme view is to declare this whole system a waste of time and resources, and to propose that the government should stop subsidizing it. The example of the "Asian Tigers"

or even Japan, who developed their modern industries and technological capabilities without significant system for basic research, is brought to bear. "All this idea of supporting basic science is nonsense. One should close it down, stop giving money to the researchers, make the universities give up doing research of any kind, and put all money in industrial, applied research."

One difficulty with this proposal is that it is not clear that if you put all the money in industrial research, the industry would take it and use it actually to improve their technological capabilities. This is indeed an important question: why doesn't the industrial sector, the productive sector, do more research, more innovation? Part of the answer is that in the past they were protected by the import substitution policy and they didn't need to, because they had the internal market for their own. But now they are not protected anymore, are forced to become more competitive. But it is far from obvious that the incorporation of technological capabilities is the best instrument for that. It is also possible to buy ready-made technological packages, or to enter in association with large multinational corporations that already have their technologies and do their research elsewhere.

So it may just be that, if you closed down academic research and tried to support only industrial research, you would lose one thing and not get the other. The other point, of course, is that you have an installed capability. With all its drawbacks and limitations, the research network that exists today in Brazil includes outstanding groups and institutions, talents and competence which should be preserved, simulated and put to the best possible use.

The recommendation we came up in our science and technology policy paper was that, first, Brazil should maintain and protect whatever capability it has, and also try to improve on that. At the same time, mechanisms should be created to stimulate closer links and associations with users of scientific knowledge and competence, both in the private and in the public sector. There should be two mechanisms for science support, one based on strict criteria of quality, the other strongly influenced by criteria of social and economic relevance, and one should influence the other. There is nothing new or revolutionary in this proposal, except that it has still to be implemented.

Science can be relevant not only for the development of applications, but also - and probably mainly - to educate people. Scientific research developed in Brazil mostly in universities, under the assumption that it would benefit the whole educational system. In practice, the system of incentives and support led the researchers away from the classroom. I would like to argue, to conclude this presentation, that, although the scientists may resent it at first, a closer approximation between research and teaching can be very beneficial to both. I'll just give an example from my own field, the social sciences. In Brazil today there are no good textbooks for the students in the social sciences, which, if taken in a broad sense - including administration, economics, law, and others - comprise about 30 to 40% of the total enrollment. You don't see our good social scientists taking as their own task to provide good textbooks for the students. So I think there's a huge - if you can make it more general - there is a huge task for those well-qualified

people who are in research departments, to get more engaged, in a more systematic way, in a more direct way, into education. If they did this, they would become much more relevant than today, they would get more resources for their academic projects, and the quality of their research would probably also improve, because they would have to say clear and relevant things for hundreds of thousands of students every year.

So, the basic recommendation is that you should keep open the space for the more traditional type of academic research, and should also establish explicit links between resources and very strong, explicit and well-identified goals related to applied work in the industrial sector or in dealing with the relevant social problems, and in education. The links between research and education cannot remain simply as a *general* assumption, but should be made explicit, according to a new understanding of how the educational system should develop. We are already moving in this directly, although still very slowly.

Thank you.